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SEVENTH QUARTERLY REPORT

SOLAR THERMIONIC

GENERATOR DEVELOPMENT

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SEVENTH QUARTERLY REPORT
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Summary

This report covers progress for the seventh quarter, corresponding to the period from June 8, 1967, to August 31, 1967.

During this quarter, converter T-206 was re-tested and converter T-207 was fabricated.

Converter T-206 was tested with a new electron-bombardment filament of the U-type recommended in the Sixth Quarterly Report. The test showed very small differences between the performance observed with this type of filament and that with the previous S-type filament. Since the S filament produces a more uniform temperature distribution in the emitter, it is recommended that converter testing continue to be conducted with this type of filament.

As originally planned, converter T-207 was fabricated with a palladium collector. Fabrication was completed at the end of this quarter, and test results should be available by the end of the next quarter.

Re-Test of Converter T-206

Converter T-206 was received from JPL and was placed back on test with a U-type electron-bombardment filament. This filament structure was recommended to JPL after some tests indicated that, with certain electron-bombardment filament geometries, it is possible to produce localized electron bombardment of the wall of the hohlraum used for emitter temperature measurements. With a circular filament,

described in the Sixth Quarterly Report, a change of as much as 42°C had been observed in the apparent temperature of the hohlraum under otherwise identical test conditions.

The U-type filament is designed to avoid electron bombardment of any portion of the emitter structure close to the hohlraum. The electron-bombardment filament projections onto the emitter structure are approximately 0.160 in. from the hohlraum.

The data sheet for Run No. 8 shows the results obtained with the U-type filament, and the Sixth Quarterly Report gives the data originally obtained from converter T-206 using an S-type filament. The tests conducted with the U-type filament were intended to reproduce two conditions in particular: the outputs at 1 volt and 0.8 volt with electron-bombardment power inputs of 292.4 and 344.8 watts, respectively. Sheet 4 of the original T-206 data gives recorded output currents of 23.3 and 41.2 amperes, respectively. With the U-type filament, the values obtained were 21.6 and 40.9 amperes, and the observed emitter temperatures were 15°C higher. These results are summarized in Table I.

TABLE I

	S Filament	U Filament	Change
Output Current at 1 v	23.3	21.6	-7.3%
0.8 v	41.2	40.9	-0.7%
Hohlraum Temperature	1700	1715	+15°C

The higher emitter temperature readings obtained with the U filament are surprising because avoiding bombardment of the hohlraum would

normally be expected to reduce hohlraum temperature. The discrepancy of 7% observed at 1 volt could be due to experimental error because of the output sensitivity to power input in the 1-volt region. The results tend to confirm, in general, that the observed emitter temperature is affected by the type of electron-bombardment filament used, and the converter output observed is a sole function of the electron-bombardment power input.

Since the results obtained with the S- and U-type filaments are in close agreement, and since an S-type filament has been used for all previous tests and is capable of more uniform heating of the emitter face, it is recommended to JPL that the use of the S-type filament be continued for all further converter tests.

Fabrication of Converter T-207

Converter T-207 was fabricated with care to produce a structure which, except for the collector material, would reproduce as accurately as possible that of converter T-206.

The emitter used for the fabrication of T-207 was prepared at the same time as that used for T-206. Both emitters were lapped to a mirror finish and electroetched at 5 volts, 1 ampere for 1 minute. Both emitters were thermally stabilized for 2 hours; the temperature for T-206 was 2100°C, and that for T-207 2000°C. The lower temperature was due to space charge in the electron-bombardment heat source used for thermal treatment which limited the maximum power input. According to the experience gained in this program, the effect of the lower heat-treating temperature should be negligibly small. The space-charge limitation was due to excessive filament-to-target

distance and to the smaller filament area of the U-type filament used for T-207 in place of the S-type. This change in filament may also have been responsible for some distortion of the T-207 emitter. Final flatness checks for T-206 and T-207 compared as follows, in inches:

	T-206	T-207
Emitter quadrant I	0.00005	0.0004
II	0.00000	0.0000
III	0.00005	0.0004
IV	0.00000	0.0000
Emitter center	0.00000	0.0000
Seal flange quandrant I	0.0005	-0.0025
II	-0.0002	-0.0030
III	0.0000	0.0020
IV	0.0006	0.0014

As can be observed, the emitter of T-207 after thermal treatment had eight times more distortion than that of T-206. The actual amount of distortion of the T-207 emitter is about 20% of the interelectrode spacing and should not produce a noticeable change in converter performance, although it exceeds the estimated flatness requirement of a maximum allowable distortion of 10% of the interelectrode spacing. Converter T-207 also had a greater deviation from squareness of the seal flange. The values given above correspond to a misalignment of 15 minutes of arc, which is reasonably close to the desired value of 10 minutes of arc.

Converter T-207 was fabricated using a pressure-bonded palladium collector which was prepared earlier in the program. The assembly of the palladium collector is described in the Fourth Quarterly Report. The surface preparation of the collector consisted only of a surface grinding and polishing operation. The rest of the collector-radiator structure of converter T-207 was identical to that of T-206.

The final assembly of T-207 was defective in one respect: the stainless steel support ring, part No. 19, was not brazed to the copper fins. This defect was due to an excessive rate of warm-up of the assembly during final brazing; the support ring was considerably hotter than the radiator fins when the brazing material at the joint melted, and the braze flowed only on the support ring. The final assembly is shown in Figure 1.

Converter T-207 was outgassed for 65 hours at an observed emitter temperature of 1675°C. Cesium distillation was conducted for 5 hours at 200°C.

Plans for the Next Quarter

During the next quarter, converter T-207 will be tested. The design of converter T-208 will be presented for approval. This will be a converter incorporating the collector-radiator heat pipe T/E-4 to be fabricated and tested under the concurrent contract JPL 951465. A preliminary layout of a 16-converter generator will be prepared to serve as a basis for final calculation of predicted generator performance, and for the production of a detailed set of engineering drawings for generator fabrication.

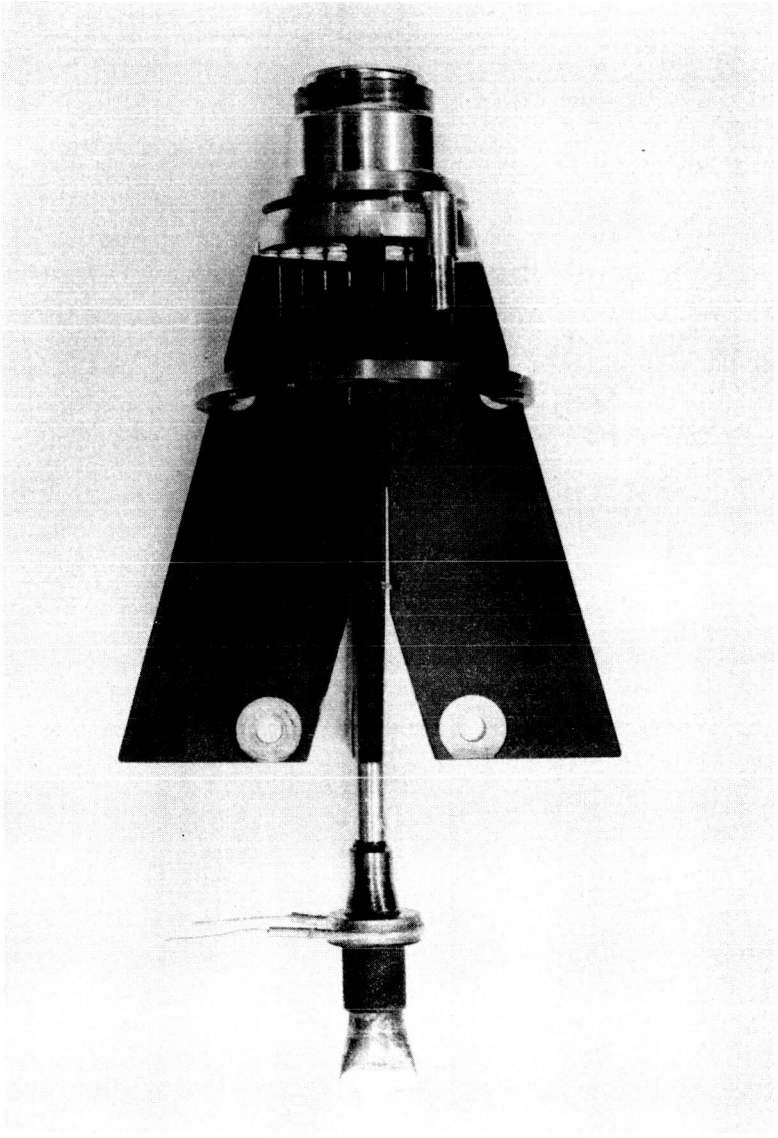

Figure 1.

THERMO ELECTRON
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Sheet 1 of 1

Converter No. T-206 Run No. 8 Observer P. Brosens

VARIABLE		1	2	3	4	5	6	7	8	9	10
Date		7-21	7-24	7-25	7-25	7-25	7-26				
Time		14:12	15:07	9:30	11:25	14:05	9:59				
Elapsed Time, Hours		.00	4.4	22.8	24.6	27.2	47.1				
T_O, °C		1700	1697	1699	1698	1698	1700				
T_O Corrected, °C		1706	1703	1705	1704	1704	1706				
$\Delta T_{Bell\ Jar}$, °C		11	11	11	11	11	11				
T_H, °C		1717	1714	1716	1715	1715	1717				
ΔT_E, °C		23	23	23	23	31	31				
T_E, °K		1967	1964	1966	1965	1957	1959				
V_o, volts		.982	.996	1.000	1.003	.787	.799				
I_o, amps		22.9	22.2	21.6	21.9	40.9	41.2				
P_o, watts											
I-V Trace No.			(2)		(3)		(4)				
T_R	mv	13.1	13.6	13.3	13.2	13.9	14.0				
	°C	321	333	326	324	341	343				
	°K	594	606	599	597	614	616				
T_C	mv	(1)	26.9	26.5	26.5	30.1	30.2				
	°C		647	637	637	723	725				
	°K		920	910	910	996	998				
T_C base inner	mv										
	°C										
T_C base outer	mv										
	°C										
$T_{Radiator}$	mv										
	°C										
V_{eb}, volts		975	976	975	976	970	967				
I_{eb}, mA		300.2	301.9	300.4	302.9	356.3	358.2				
$E_{Filament}$, volts		4.8	4.9	4.8	4.8	4.9	4.9				
$I_{Filament}$, amps		19.5	19.5	19	19	19.5	19.5				
$I_{Coll.Heater}$, amps		—	—	—	—	—	—				
$I_{Res.Heater}$, amps		~2	2.63	2.63	2.56	2.59	2.59				
Vacuum, 10^{-6} mm Hg		3.0	3.6	2.2	2.2	2.2	2.1				
Measured Efficiency, $\%_{EB\ Power}$		292.5	294.5	292.7	295.5	345.5	346.5				

NOTES: (1) TC SHORTED - VOLTAGE TAPS REVERSE POLARITY - STOPPED TESTING TO CORRECT WIRING.
(2) LEFT TO RUN OVERNIGHT.
(3) SHIFTED LOAD TO CHECK 0.8 volt OUTPUT.
(4) END OF TEST.